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PUBLIC HEALTH REPORTS.

PLAGUE AMONG GROUND SQUIRRELS IN CONTRA COSTA COUNTY, CALIFORNIA.

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HUMAN PLAGUE.

In August, 1903, a blacksmith from the town of Pacheco, Contra Costa County, was admitted to the German hospital in San Francisco suffering from plague, from which he subsequently died. While investigating his case Surgeon Rupert Blue was struck with the fact that the patient had shot ground squirrels three or four days prior to his illness. Inasmuch as he had not visited Oakland or San Francisco, which were then infected points, for over a month prior to his taking sick, it was evident that the infection had been contracted in Contra Costa County, and it was thought not improbable that the ground squirrel was the agent concerned in the transmission of the infection. In September of the same year a man employed in the construction of a railroad bridge near Danville died of bubonic plague in the Southern Pacific Hospital in San Francisco. He had been working for some time in San Ramon Valley, and had lived in a railroad camp where ground squirrels were frequently killed and used as articles of food.

In 1904 a woman living near Concord, Cal., died of the disease, and in the investigation which followed Passed Assistant Surgeon Donald H. Currie made a series of experiments which proved conclusively the susceptibility of the ground squirrel to bubonic plague. No suspicious cases were reported during the summer of 1904 or 1905, but in 1907, immediately after the earthquake, Doctor Blue saw a boy suffering from bubonic plague of the multiple bubonic type. This patient had shot squirrels in the Strawberry Canyon in the Berkeley Hills adjoining Contra Costa County, three or four days before he was taken ill. He stated that in several instances he was obliged to thrust his arm down in the squirrel burrow in order to extract the animal he had shot. It is quite easy to see how in this way he may have been bitten by a flea infected with plague. He recovered.

On July 15, 1908, a boy living on a ranch in the northern part of the county, about midway between Concord and Antioch, died of the disease, and on July 28 a young lady died of the disease at the head of the Pinole Canyon (usually called Briones Valley), midway between Martinez and Pinole. In both these latter cases an intimate association with ground squirrels was shown.

RODENT PLAGUE.

In 1903, while investigating the case of the blacksmith in Pacheco, Doctor Blue pointed out the possibility of the ground squirrel acting in the same rôle as the rat in the transmission of the disease. Doctor Currie's investigations served to confirm him in this belief, but it was not until 1908, in the investigation which followed the two human cases mentioned above, that natural plague in ground squirrels was demonstrated. It was known as early as 1903 that an epizootic was spreading among the ground squirrels, but in spite of many attempts on Doctor Blue's part and the offer of liberal rewards no naturally infected squirrels could be secured. In 1908 infected rats were found on a ranch adjoining that on which the boy died of plague, and in the autumn of the same year an infected squirrel was found near the house in which he had lived. A little later three infected squirrels were found near Bay Point, a few miles north of this place. This epizootic has continued until the present date, but it does not seem at present to kill as many ground squirrels as during the earlier years. It is stated by those who observed the squirrels closely at that time that they died by the thousands. They would emerge from their holes and stagger about as though they were intoxicated. Their fur was turned the wrong way, and, in many instances, they were emaciated and presented swellings beneath the jaws or in the axillæ. They were seen crawling on the ground in a dazed condition, apparently having lost all sense of direction, and could be easily killed with a stick. Several intelligent ranchers state that they opened the bodies of several of these squirrels, and that their lungs were dark red in color and resembled liver in consistence. They may have suffered from the pneumonic form of the disease. Undoubtedly many died in their holes; in fact, some of the ranchers state that the holes were so full of dead squirrels that no more could get in, and the others consequently died on the ground. As a result buzzards came in great flocks, and the air was charged with the stench of the decomposing bodies. For a time they decreased so greatly in numbers that it seemed as if the county had been permanently rid of an animal which had been a perennial pest, destroying many thousand dollars' worth of crops annually.

The epizootic is supposed to have entered the county by one of three routes, from the northern part along the coast of Suisun Bay, or by way of Moragua Valley on the west, or the Niles Canyon on the south. It is thought by many that the infection was imported by the rats from the sugar ships coming from Honolulu and anchoring along the coast of Suisun Bay. Be this as it may, the infection rapidly spread throughout the entire county. In 1906 the squirrel population, which, as has been stated, was tremendously diminished by the epizootic, began to increase again, and, while it has not reached its original numbers, it is only a question of time until this occurs unless some eradivative measures are directed against them.

THE GROUND SQUIRREL.

The ground squirrel most commonly found in this county is the *Otospermophilus Beecheyi* (Richardson), or *Citellus Beecheyi*, belonging to the Arctomyinæ. The following description is given by

Edgar Alexander Mearns, M. D., U. S. Army, in "Mammals of the Mexican Boundary of the United States," Bulletin 56 (1907), U. S. National Museum, pages 324-325:

Size smaller than *Otospermophilus grammurus* (nearly as large as the eastern gray squirrel) with a more slender body and shorter tail. Ears high and pointed. Mammaræ, six pairs (P. $\frac{2}{3}$, A. $\frac{3}{4}$, I. $\frac{3}{4}$ =12). Color above brown, grizzled, and annulated with black in a vermicular pattern; darkest anteriorly, and most grizzled and vermiculated posteriorly. Nape and sides of neck silver gray; this color prolonged backward above the shoulder in the form of stripes which are sometimes faintly traceable to the root of the tail, though usually ending about the middle of the body. Ears black outside, grayish or faintly rusty inside, and along posterior border. Top of head bistre, slightly dusky above orbits, which are encircled by white. Sides of head grayish, mixed with yellowish brown. The tail, which is less bushy and shorter than in *O. grammurus*, is yellowish gray, the lateral hairs thrice annulated with black. Feet yellowish gray. Under surface of the body grayish white. The interscapular region is often blackish, more or less vermiculated with pale annuli. Length, 410 mm.; tail vertebrae, 170; hind foot, 55; ear above crown, 21; ear above notch, 27; length of head, 62; skull, 57 by 34 mm.

They usually exist in colonies, sometimes digging very extensive burrows which often honeycomb an entire hillside. The entrances to the burrows are approached by paths 2 or 3 inches wide worn in the grass by the running to and fro of the animal. Soft ground is usually chosen for digging the warren, but sometimes they burrow into hard adobe, and, in certain localities, they dig extensive tunnels in the soft limestone. The earth dislodged in digging the burrows is piled in a mound at the entrance of the hole. The tunnel usually makes a sharp preliminary drop and then points upward a distance of 2 or 3 feet. It then forks, one branch going to the storehouse and the other to the nest. Collateral branches are given off from these two main avenues to the various exits. The nest is built of straw, pieces of bark, and similar débris, and usually contains a great number of fleas. In the storehouse grain, fruit, and several varieties of wild seeds are laid by for the winter season. These are carried there in the cheek pouches of the animal. They may be observed playing about or eating the grain and seeds on which they subsist, and usually there are one or two sitting bolt upright by the entrance to the burrow. On the approach of the hunter they will whistle, and after a short time it is very easy to recognize the meaning of these signals. If one sharp whistle is given, the animal will usually sit still, and it is possible to get a shot. If he gives one sharp whistle and goes down into the hole, it is safe to wait a few minutes for him, but if he gives one sharp whistle followed by two or three trills in a descending scale it is simply a waste of time to wait for him to come out, because he has been thoroughly frightened and may not reappear for two or three hours. They spend the winters—that is, the wet months—in the foothills, and there the young are born in late March and early April. The litter varies from five to seven. In late April and early May most of the young squirrels have grown sufficiently to travel, and an emigration into the lowlands begins. This is not completed until late May, when the grain crops are harvested. By this time food in the hills has become relatively scarce, and the animals, descending into the valleys, subsist on fruit, garden truck, and grain. In the former instance their activities are particularly pernicious, and they have frequently been seen to cut off small branches laden with unripe prunes and drag them into their hole. While they do not build nests in the trees, they frequently dig extensive burrows at their roots,

and occasionally they are seen in the branches gathering nuts. They are very fond of elderberries, and will climb the trees in search of them.

SQUIRRELS AS HUMAN FOOD.

For many years a considerable proportion of the population of this region has eaten ground squirrels at certain seasons of the year, and it is stated that when in good flesh they are as good as, if not superior to, rabbits. Several families have been found who are in the habit of salting them down in large numbers and using them almost to the exclusion of other meats. In all probability the eating of squirrels is not in itself dangerous, provided they are well cooked, but the danger lies in the handling of them prior to cooking; that is, in skinning and preparing them. There are a large number of men who make their living by hunting these animals for the markets, and, until recently, large daily shipments were made. Realizing the danger of such a practice, Doctor Blue invited the attention of the state board of health to it, and, at his request, a resolution was passed forbidding the acceptance of ground squirrels for shipment by express companies and common carriers, unless accompanied by a certificate to the effect that they were intended for scientific purposes, and carried in sealed metal cans. This succeeded in a measure in putting a stop to this dangerous business, but a large number of private hunters continued to come into the county. The matter was then brought to the attention of the mayors of Oakland, Berkeley, and Alameda, with the result that the people were warned against the use of ground squirrels for food. An inspector was also stationed at the Fish ranch on the Tunnel road, which is the main thoroughfare into the county, with instructions to inform all persons passing with bags of squirrels of the danger to which they were exposing themselves. As a result, the practice of eating squirrels has very greatly diminished, and the market hunters have been obliged to seek other employment.

CONNECTION BETWEEN THE GROUND SQUIRREL AND BUBONIC PLAGUE.

In other parts of the world—eastern Siberia, northern Mongolia, and the base of the Himalayas, in northern India—it has been observed that an epizootic spreads among the *Arctomyinæ*, and that persons eating and handling these rodents contract bubonic plague. This has been treated of by several authors, notably Beliatzky, Reschtnikoff, Zabolotny, Rudenko, and Bannerman. These various authors give a description of an epizootic which very closely resembles that observed in Contra Costa County. It was not, however, proved that the disease existed among the *Arctomyinæ* of America until the summer of 1908. This fact, however, was considered of sufficient importance to warrant the beginning of an antiplague campaign in Contra Costa County.

There is reason to believe that the booby owl, which is a constant companion of the ground squirrel, occupying the same burrows with him, may play an important rôle in the dissemination of the epizootic. It is thought that this bird, flying from burrow to burrow, may carry infected fleas for long distances. If this be found true, the problem of the eradication of the epizootic will thereby be greatly complicated. Some of the ranchers of this vicinity firmly believe that the

booby owl does not harbor fleas, and state that it will transport horse manure long distances for the purpose of lining its nest. Their contention is that the ammonia generated by the decomposing manure will inhibit the growth and multiplication of fleas. As yet, no opportunity has occurred to disprove or verify this statement.

In 1909 a campaign against the ground squirrel was inaugurated. The immediate charge of the work was assigned to Passed Asst. Surg. W. C. Rucker, who had conducted part of the investigations during the previous summer, and was thoroughly familiar with the ground to be covered. Experiments were made with the various agents to be used in the destruction of ground squirrels, and an endeavor was made to obtain samples of the squirrel population from all parts of the county.

LOCATION AND TOPOGRAPHY OF CONTRA COSTA COUNTY.

Contra Costa County is one of the central counties of the State. It is bounded entirely on the west, north, and east by water, its western boundary being San Francisco Bay, its northern boundary the San Pablo and Suisun bays, its eastern boundary the San Joaquin River, and its southern boundary Alameda County. It is also bounded, to a certain extent, on the west by Alameda County, and is, therefore, in close proximity to all of the bay cities. Its western boundary line is within 9 miles of San Francisco and adjoins Berkeley. Its area is 734 square miles, or about 444,491 acres. Its topography is semimountainous with broad, rich, intervening valleys. Besides the range of hills bordering the western and northern portions of the county, there are two ranges of hills running in a general northerly and southerly direction, with large productive intervening valleys watered by substantial streams. In the center of the county stands Mount Diablo, a rugged peak about 3,800 feet in height. The valleys of Alhambra, Pacheco, Ignacio, Clayton, and San Ramon extend from Suisun Bay at Martinez on the north to the southern boundary line of the county beyond San Ramon. Numerous smaller valleys give off from these, and the great San Joaquin Valley begins in eastern Contra Costa County, extending from Mount Diablo on the west to the San Joaquin River on the east. The rich valleys afford an abundant food supply for the squirrel population, while the wild hill lands shelter them in winter from the rains and from human and animal foes. The proximity of the county to the bay cities, which have until recently been plague infected, and the constant presence of ships coming from oriental ports, in Suisun Bay, demonstrate how easily the infection could have been introduced into the county, and how readily it could be transferred to the cities, which have just been rid of plague at such great cost. The large area to be covered, the wide spread of the infection, and the character of the terrain all combine to render the campaign exceedingly difficult.

SQUIRREL ERADICATIVE AGENTS.

Poisonous gases—(1) *Carbon bisulphide*.—Two agents were found which gave good results in the poisoning of squirrels. The first of these was commercial carbon bisulphide. The carbon bisulphide of commerce is usually sold in 5-gallon zinc-lined cans. These are quite

heavy, and it is not wise to carry them. When poisoning, a 2-quart glass fruit jar having a screw top is best for the purpose. Waste is made up into balls and loosely tied with a string. Several of these balls are kept in the jar which is half full of carbon bisulphide, and when it is desired to place one in a hole they are taken up with a large pair of forceps made of heavy wire. Bisulphide should not be brought in contact with the skin, as its rapid evaporation will freeze the part and produce scars which heal with considerable difficulty. To use carbon bisulphide a piece of waste the size of an orange is saturated with the fluid and the wet ball placed in the mouth of the squirrel hole. When the saturated ball has been placed in the hole, earth is tamped tightly upon it so that the gas which is generated may have no opportunity to escape. All of the holes of the burrow are treated in this way. In some instances the ball is placed deep in the hole and then ignited. This is more or less dangerous as an explosion occurs, and, while the gas is thus disseminated to all parts of the warren, its action covers only a limited period of time, and is, therefore, not as certain as the first method mentioned. Experiments are now being made with carbon-bisulphide shells which may prove a rapid and efficacious means of squirrel destruction. These consist of shells made of waxed paper which is loosely packed with waste. Leading into it on either side is an insulated wire, the bare ends of which almost meet in the center of the shell. Just prior to using the waste is saturated with carbon bisulphide. When an electrical current is passed through the wire it sparks across the gap, thus igniting the bisulphide and producing an explosion. If one of these shells were placed in each hole of the warren and the earth tightly tamped behind it, and all discharged simultaneously, it is believed that the shock alone would be sufficient to kill everything in the warren.

Several of the manufacturers of pyrotechnic supplies are placing on the market shells which produce much smoke and gas and which are said to be useful in the extermination of squirrels.

Pumps: Thus far none of the pumps for introducing bisulphide into the tunnels has proven ideal. Many of them are efficacious, but are very heavy and slow in their delivery of gas. It is believed that a light and simple apparatus can be made by attaching an automobile pump to a tube guarded by a valve and leading to the bottom of a large square tin can, from the upper surface of which would lead a hose for carrying the gas into the hole. By pumping air through the can of bisulphide the gas would be generated and could thus be rapidly forced into the subterranean tunnels. Carbon bisulphide seems to be an ideal agent for the extermination of squirrels in a plague campaign, for the reason that it not only kills the squirrel but also the fleas upon him and in the tunnels, thus precluding the possibility of infected fleas remaining to perpetuate the epizootic in another colony of squirrels subsequently occupying the same burrow. The chief disadvantages of carbon bisulphide are its high explosive power, its liability to corrode the cans in which it is kept, and its cost, $11\frac{1}{2}$ to 12 cents per pound in the California market. It can not be used when the ground is dry and cracked, and can, therefore, be applied with success only during the wet or winter months.

(2) *Sulphur dioxide*.—Sulphur dioxide, if properly applied, would fulfill all of the requirements of an ideal agent for poisoning squirrels. It is cheap and nonexplosive. It would kill both the squirrel and

his parasites. Thus far only one hand pump for introducing the gas produced by burning sulphur has been found on the market. If it could be obtained cheaply enough, compressed sulphur dioxide would be practicable. In common with all other gases, however, it is efficacious only when the ground is wet. The fluid obtained on cleaning Pintsch gas tanks has been recommended. It is cheap and said to be efficacious, but it is not easy to secure it in sufficient quantity for carrying on a work of this kind. Experiments are now being made with a view to determining the merit of this product as a pulicide.

(3) *Hydrocyanic-acid gas*.—Hydrocyanic-acid gas used with proper precautions is a most excellent agent for exterminating the squirrels. It should not, however, be entrusted to careless or ignorant people, but only persons who have been carefully instructed as to its dangers and method of use should be allowed to employ it. A small tin pan 3 inches in diameter and 1 inch in depth containing 100 c. c. of 10 per cent sulphuric acid is set in the squirrel hole. All of the other holes of the warren are carefully tamped so that they are gas tight. A quantity of wet clay or adobe is placed near the mouth of the hole in which the gas is to be generated. One gram of potassium cyanide in a small paper bag is then placed in the sulphuric-acid solution. The length of time required for the acid to soak through the bag gives the workman a chance to close the hole quickly with the wet clay. The reaction which occurs may be expressed as follows: $2\text{KCN} + \text{H}_2\text{SO}_4 = 2\text{HCN} + \text{K}_2\text{SO}_4$. The gas will kill everything in the warren. This, in common with all other gaseous agents, can be used only when the ground is moist. Its advantages are its cheapness (about 7 cents per colony) and certainty. Its disadvantages are its extreme toxicity.

Poisoned grain.—The second agent which gives good success is poisoned wheat. The poisonous agent used is either strychnine sulphate or cyanide of potassium, preferably a mixture of the two, applied to wheat with a little glucose or other sweet material and then dried. The appended formula may be recommended:

Strychnine.....	ounce..	1
Cyanide of potassium.....	ounces..	2
Eggs.....	dozen..	1
Honey.....	pint..	1
Wheat or barley.....	pounds..	30

Stir eggs well, then mix in honey and again stir. Then put in dry powdered strychnine and cyanide and stir until well mixed.

Put wheat in large box or can and pour in the mixture of poison and stir until it is well distributed over the wheat. Stir two or three times during twenty-four hours, then spread out and dry. Before putting it out for the squirrels add oil of rhodium 1 drachm.

This agent is very effective when the food supply is limited, that is, during the winter months. Great care must be taken in the distribution of poisoned wheat lest domestic animals and quail and other birds be killed by it. It should all be placed in the squirrel hole itself, and never on the surface of the ground. This is especially necessary in pastures when the food is short, because valuable cattle cropping the grass close to the ground are apt to take it and be killed. It will thus be seen that the ideal time to carry on a squirrel eradication campaign is the rainy season, as the squirrels are then localized in the foothills, the ground will hold the poisonous gas, and the reduced food supply will cause the consumption of the poisoned wheat.

Phosphorus.—Phosphorus has not proven as useful in the destruction of ground squirrels as in the poisoning of rats. It is dangerous to handle and serious fires may be started with it. After a few days exposure to the open air and the bright sunshine it quickly loses its toxic power, and it is therefore not recommended for this work.

Flooding.—Where there is a sufficient fall of water, flooding the squirrel warren will drive the squirrels out very effectually. If men are stationed around the edge of the colony with guns or clubs, great numbers may be slain, but flooding is useless unless this is done, because the squirrels will simply migrate to the high lands, to return as soon as their burrows are dry.

Natural enemies.—It has been hoped that some use might be made of the natural enemies of the squirrel in this campaign, but no one of the known natural enemies is ideal for this purpose. The coyote, wolf, fox, badger, skunk, mountain lion, gopher snake, and red-tailed hawk all prey upon the squirrel, but each is open to some objection. This matter is, however, being carefully studied out, and some plan may be evolved whereby use can be made of this means of killing squirrels. Several young sparrow hawks have been secured, and an endeavor is being made to train these birds to hunt squirrels, much as falcons were used in olden days. This may prove very useful on flat lands, where a hunter can not get close enough to the squirrels to secure a shot.

Traps.—Several varieties of traps have been experimented with, but none have proven very successful. A squirrel is a very wary animal, and he will not enter his hole if he sees anything unusual therein. So simple a thing as a ball of paper placed in the mouth of the hole will cause him to abandon that particular runway. Experiments are now being made with snares. These are made of fine wire, and it is hoped that in this way a large number of ground squirrels may be captured alive. This will afford the laboratory an opportunity to study the susceptibility to plague of squirrels from an infected locality, and a few may be captured in the early stages of plague, thus rendering it possible to study the natural form of the disease at close range.

Shooting.—After the preliminary experiments with the various poisonous agents, which could be conducted only while the ground was moist and the squirrels' food supply scanty, an endeavor was made to secure samples of the squirrel population from all portions of the county in order to determine the exact extent of the infection and, if possible, its percentage. A number of men were, therefore, stationed by the officer in charge at what were considered strategic points. For the most part these employees were taken from among the men who had been trained in the field work in San Francisco. Each was supplied with a single-barreled, 12-gauge shotgun, a cleaning rod, canvas knapsack, canvas-covered aluminum canteen, ammunition, squirrel tags, cans, chloroform, solder, indelible pencils, report blanks, and stationery. Unless the hunter wears some protection for the shoulder it may become bruised by the recoil of the gun. Each hunter, therefore, wears over the gun shoulder a pad of soft felt an inch in thickness, such as is used beneath horse collars. It was not found practicable to use rifles in this work on account of their danger to stock and the fact that, as a rule, they do not kill the ground squirrel outright. Until the fields became very dry it was practicable to use

shells loaded with black powder in the proportion of $3\frac{1}{4}$ drachms of powder to $1\frac{1}{8}$ ounces of No. 8 soft shot. Later, on account of the danger of setting fire to the dry fields with the burning wads, it was found necessary to substitute smokeless powder. Ground squirrels are very hard to secure after having been shot. Frequently, even though badly mangled, they will crawl into their holes, and thus escape. The ideal charge for securing ground squirrels for purposes of examination is that which gives the maximum shock with the minimum laceration of the tissues. No. 8 shot is large enough to fill these requirements, and so many of them striking the animal causes great shock, while they are not large enough to tear the tissues badly. It has been found that squirrels are most often secured when they are shot on the run, and that almost invariably when they are shot sitting up they will fall into a hole, and thus escape. By shooting at the running squirrel the hunter has the double advantage of striking the animal when he is spread out, while at the same time he may choose the place where he wishes him to fall. It has been found that a heavy piece of wire with a sharp barb about an inch long on the end is a very effective instrument in extracting wounded squirrels from the burrows.

Dogs are now being trained for the purpose of retrieving squirrels. This will save the hunter a great deal of work, and will enable him to secure almost all of the squirrels which he wounds. It has been found that the early morning and late afternoon are the best times of day to shoot squirrels. They ordinarily do not come out of the holes when it is very warm, very cold, or very windy. It is not profitable to hunt in the same colony for more than two or three days at a time, as the squirrels soon become very "gun shy," and take to earth as soon as anyone approaches. Under ordinary conditions a hunter should shoot and secure at least 30 squirrels per day, although when they are very numerous the day's bag may reach 60 or 65. In one instance one man shot 131 in eight hours.

SEARCH FOR DEAD SQUIRRELS.

At the beginning of the campaign it was thought that the best way to secure plague-infected squirrels would be to make a careful search for their dead bodies. The employees were, therefore, instructed to make careful search for dead squirrels in and around colonies in which they were hunting. Out of 67 thus found not one has proved to be infected. This method has not, however, been abandoned, but little is expected from it, and it is thought that it is not improbable that the plague-stricken squirrels die in their holes.

TAGGING.

The squirrels are secured as soon as shot and a tag immediately attached to each. This is necessary, because they will sometimes revive and crawl away or the hunter may lose track of them. If they are tagged as soon as shot there is no danger of mistagging them, and the handling is reduced to the minimum. The tag shows where, when, how, and by whom captured, also the name of the nearest town, to facilitate locating the ranch on the map.

SHIPMENT OF SQUIRRELS.

Each evening the squirrels are placed in tin cans especially provided for the purpose. In the can is placed 75 c. c. of commercial chloroform for the purpose of killing fleas. The lid is then tightly applied and carefully sealed with solder. The can is then tagged and sent by express to the plague laboratory in San Francisco. It will thus be seen that every precaution is taken to protect expressmen and other persons handling the cans. In hot weather the squirrels must be rushed to the laboratory with the greatest expedition, as they are likely to decompose rapidly and generate considerable gas which will blow off the covers no matter how tightly they may be secured. This causes complaints on the part of the express companies and their employees. In many instances, however, it is very difficult to forward specimens prior to their decomposition. One hunter stationed in an isolated part of the county makes it his business to know whenever the ranchers in his vicinity are going to town, and gets them to carry his squirrels to the nearest village. There they are delivered to a foreman who ships them by stage to the nearest railroad; thence they are taken to Oakland, and by ferry to San Francisco.

Where two or more men are hunting in the same district (or where the bag is unusually large) large milk cans with especially prepared rubber gaskets are used. The lids are also secured by padlocks, one key of which is kept by the man sending the can, the other remaining at the laboratory. The small cans are used but once; the large cans are returned by express.

LABORATORY EXAMINATION.

On the arrival of the cans at San Francisco they are immediately transported to the laboratory by a special messenger with a wagon. They usually arrive in time for the squirrels to be examined within twenty-four hours after they are killed. When the squirrels arrive at the laboratory they are first liberally sprinkled with chloroform, after which they are given a bath of bichloride of mercury, 1 to 1000. They are then piled upon a large lead-topped table. One employee tacks them to shingles and passes them on to a second laboratory assistant, who makes a record of the tag and gives the shingle a number, so that if the tag should be lost it will be possible to tell where the squirrel came from in case it should be found infected. The squirrel thus prepared is passed to other men who have become expert in opening small mammals through their experience in handling rats during the San Francisco plague campaign. These men are very skillful in recognizing the gross lesions of bubonic plague, and as soon as a suspicious animal is found the dissection of it ceases. The attention of the bacteriologist is called to the squirrel, and in case he is unable to look at it immediately it is covered with a damp towel for the purpose of keeping off flies should any have found entrance to the laboratory. The dissection is then finished by the medical officer in charge of the laboratory, who dictates to a clerk the findings in each particular case. They are noted on a card, which becomes a part of the card index system of the laboratory. Inoculations are made into guinea pigs, and the usual cultures planted. All squirrels are carefully examined by

the medical officer in charge of the laboratory, but so expert have his assistants become that on two occasions only have they failed to lay aside squirrels which subsequently proved infected. The value of the gross pathological findings in the recognition of plague is thus very clearly demonstrated. As soon as a suspicious or positive squirrel is found the medical officer in charge of the field operations is notified. It is the policy to discontinue work on any colony of squirrels which has presented a considerable degree of infection, it being felt that the present object in that particular locality has thus been accomplished.

DANGER TO EMPLOYEES.

In all, 178 infected squirrels were found up to August 13, 1909. They came from almost every portion of the county in which the men have been at work. It will thus be seen that the employees handling squirrels are subjected to very great risk. Every precaution has been taken to reduce this to the minimum. They have been warned of the dangers of the work, and the opportunity to receive Haffkine's prophylactic has been offered them. Several of the hunters and laboratory assistants have taken this immunizing treatment. All employees have been warned not to thrust their arms down the squirrel tunnels in an endeavor to recover animals which they have wounded. There is not only the danger of being bitten by the squirrel, but they may also pick up some infected fleas in this way. Another danger is that rattlesnakes are sometimes in the holes. In fact, several employees were nearly bitten in this way. Each hunter carries in his knapsack a ball of waste saturated with chloroform. This is for the purpose of killing the fleas upon the squirrels, or at least stupefying them to the extent that they will not leave the sack.

WINTER CAMPAIGN.

It is planned that in the autumn, when the suitable time for poisoning squirrels arrives, and the ranchers have the time to take up the matter, a general campaign of education will be instituted and an endeavor made to enlist the cooperation of every person holding land in the county. Poison will be issued gratis, and the ranchers will be asked to distribute it under the direction of inspectors of the service. The state board of health and county board of supervisors will cooperate in every way in the prosecution of this work. Aside from the fact that the eradication of the ground squirrel is a public-health measure, the rancher will also feel that it is of the very greatest benefit to him in a financial sense. For years these pests have levied a heavy annual tax, and in some instances have destroyed entire crops. Therefore the rancher will have a double reason for giving his cooperation. The fact that the Federal Government, the State, and the county have all taken up their portion of the burden will offer another reason why each individual citizen should do his part. This campaign is aimed at the eradication of what would otherwise be a permanent focus for bubonic plague, and, therefore, a constant menace to the public health of the entire nation.

**PLAGUE-INFECTED GROUND SQUIRRELS FOUND IN CONTRA COSTA COUNTRY
BETWEEN JUNE 4 AND AUGUST 13, 1909.^a**

Date.	Serial number.	Location.
June	4	1 Root's Ranch, Rancho Acalanes, Lafayette.
	12	2 Stewartsville, sec. 10, T. 1 N., R. 1 E.
	12	3 Do.
	16	4 Mount Diablo tract, Clayton, sec. 13, T. 1 N., R. 1 W.
	17	5 West Hartley, sec. 12, T. 1 N., R. 1 E.
	17	6 Do.
	17	7 Do.
	17	8 Do.
	17	9 Do.
	17	10 Do.
	17	11 Do.
	17	12 Mount Diablo tract, sec. 13, T. 1 N., R. 1 W.
	17	13 Do.
	17	14 Do.
	17	15 Stewartsville, sec. 10, T. 1 N., R. 1 E.
	18	16 Do.
	18	17 Do.
	18	18 Do.
	18	19 West Hartley, sec. 12, T. 1 N., R. 1 E.
	18	20 Do.
	18	21 Mount Diablo tract, Clayton, sec. 13, T. 1 N., R. 1 W.
	18	22 Keller's ranch, Clayton, sec. 12, T. 1 N., R. 1 W.
	18	23 Do.
	20	24 Do.
	20	25 Do.
	22	26 Mount Diablo tract, Clayton, sec. 13, T. 1 N., R. 1 W.
	23	27 Keller's ranch, Clayton, sec. 12, T. 1 N., R. 1 W.
	23	28 Do.
	23	29 Do.
	24	30 Lynch's ranch, Rancho San Ramon (Norris).
	25	31 Nortonville road, sec. 8, T. 1 N., R. 1 E.
	25	32 Bailey's ranch, sec. 18, T. 1 N., R. 1 E.
	25	33 Do.
	28	34 Keller's ranch, Clayton, sec. 12, T. 1 N., R. 1 W.
	29	35 Lynch's ranch, Rancho San Ramon (Norris).
	30	36 Do.
	30	37 Do.
	30	38 Do.
July	1	39 Keller's ranch, Clayton, sec. 12, T. 1 N., R. 1 W.
	2	40 Do.
	2	41 Azaveda ranch, sec. 3, T. 1 S., R. 1 E.
	6	42 Keller's ranch, Clayton, sec. 12, T. 1 N., R. 1 W.
	7	43 McCabe ranch, Byron, sec. 10, T. 1 S., R. 3 E.
	7	44 Nortonville road, sec. 8, T. 1 N., R. 1 E.
	7	45 Keller's ranch, Clayton, sec. 12, T. 1 N., R. 1 W.
	7	46 Do.
	7	47 Naphtaly's ranch, Walnut Creek, sec. 3, T. 1 S., R. 2.
	7	48 Bucholtz ranch, Rancho Cañada de los Vaqueros.
	8	49 Naphtaly's ranch, Walnut Creek, sec. 3, T. 1 S., R. 2 W.
	8	50 Joaquin ranch, Clayton, sec. 24, T. 1 N., R. 1 W.
	8	51 Do.
	9	52 Naphtaly's ranch, Walnut Creek, sec. 3, T. 1 S., R. 2 W.
	9	53 Do.
	9	54 Gunther's ranch, Clayton, NW. $\frac{1}{4}$, sec. 18, T. 1 N., R. 1 E.
	10	55 Naphtaly's ranch, Walnut Creek, sec. 3, T. 1 S., R. 2 W.
	10	56 Mattos ranch, sec. 10, T. 1 S., R. 1 E.
	12	57 Bosco Grant, Rancho Cañada de los Vaqueros.
	13	58 Meredith's ranch, Clayton, SW. $\frac{1}{4}$, sec. 7, T. 1 N., R. 1 E.
	13	59 Do.
	13	60 Madsen Bros. ranch, Rancho Laguna de los Palos Colorados.
	14	61 Fraguellas ranch, Rancho Cañada de los Vaqueros.
	14	62 Keller's ranch, Clayton, sec. 12, T. 1 N., R. 1 W.
	15	63 Do.
	15	64 Do.
	15	65 Do.
	15	66 Fraguellas ranch, Rancho Cañada de los Vaqueros.
	15	67 Cope ranch, Danville, sec. 9, T. 1 S., R. 1 W.
	17	68 Meredith's ranch, Clayton, SW. $\frac{1}{4}$, sec. 7, T. 1 N., R. 1 E.
	17	69 Do.
	17	70 Keller's ranch, Clayton, sec. 12, T. 1 N., R. 1 W.
	17	71 Knox ranch, Danville, north of sec. 10, T. 1 S., R. 1 W.
	17	72 Lucas ranch, Rancho Laguna de los Palos Colorados.
	17	73 Madsen Bros. ranch, Laguna de los Palos Colorados (rancho).
	18	74 Tormey's ranch, Clayton, sec. 27, T. 2 N., R. 1 W.
	19	75 Taylor's ranch, sec. 10, T. 1 S., R. 3 W.
	19	76 Do.

^a Previous to June 4, 1909, 4 infected squirrels had been found as follows: August 5, 1908, at Farias ranch, Concord, 1; August 29, 1908, at Morton ranch, 1; August 25, 1908, at Southern Pacific Railroad tracks, near Morton Foundry, 1; September 19, 1908, in field near Bay Point, 1.

PLAGUE-INFECTED GROUND SQUIRRELS FOUND IN CONTRA COSTA COUNTY
BETWEEN JUNE 4 AND AUGUST 13, 1909—Continued.

Date.	Serial number.	Location.
July 19	77	Taylor's ranch, sec. 10, T. 1 S., R. 3 W.
19	78	Do.
19	79	Meredith's ranch, Clayton, SW. $\frac{1}{4}$, sec. 7, T. 1 N., R. 1 E.
19	80	Do.
20	81	Do.
20	82	Do.
20	83	Sherburne's ranch, sec. 35, T. 1 S., R. 1 W.
21	84	Lewis ranch, Curry Cañon, Morgan Territory, sec. 4, T. 1 S., R. 1 E.
21	85	Mount Diablo Tract, Clayton, sec. 13, T. 1 N., R. 1 W.
21	86	Devlin's ranch, sec. 10, T. 1 S., R. 3 W.
22	87	Sturgis ranch, Hookston, Rancho Cañada del Hambre.
22	88	Meredith's ranch, Clayton, SW. $\frac{1}{4}$, sec. 7, T. 1 N., R. 1 E.
22	89	Morese ranch, Danville, sec. 31, T. 1 S., R. 1 W.
22	90	Keller's ranch, Clayton, sec. 12, T. 1 N., R. 1 W.
22	91	Dario's ranch, Rancho Cañada de los Vaqueros.
22	92	Do.
22	93	Do.
22	94	Do.
23	95	Domingo's ranch, sec. 15, T. 1 S., R. 3 W.
23	96	Meredith's ranch, Clayton, SW. $\frac{1}{4}$, sec. 7, T. 1 N., R. 1 E.
23	97	Cardoza ranch, sec. 20, T. 1 N., R. 1 E.
23	98	Do.
23	99	Do.
23	100	Do.
25	101	Meredith's ranch, Clayton, SW. $\frac{1}{4}$, sec. 7, T. 1 N., R. 1 E.
25	102	Keller's ranch, Clayton, sec. 12, T. 1 N., R. 1 W.
25	103	Cardoza ranch, Morgan Territory, sec. 20, T. 1 N., R. 1 E.
26	104	Meredith's ranch, Clayton, SW. $\frac{1}{4}$, sec. 7, T. 1 N., R. 1 E.
26	105	Brubeck's ranch, Rancho Arroyo de las Nueces y Bolbones.
26	106	Do.
26	107	Do.
26	108	Hartz's ranch, Danville, Rancho San Ramon (Carpentier).
27	109	Brubeck's ranch, Walnut Creek. (See 105.)
27	110	Do.
27	111	Do.
27	112	Bailey's ranch, Clayton, sec. 18, T. 1 N., R. 1 E.
27	113	Do.
27	114	Rose ranch, sec. 23, T. 1 S., R. 3 W.
27	115	Do.
27	116	Naphtaly's ranch, Walnut Creek, sec. 3, T. 1 S., R. 2 W.
27	117	Do.
28	118	Sturgis ranch, Walnut Creek, Rancho Cañada del Hambre.
28	119	Naphtaly's ranch, Walnut Creek, sec. 3, T. 1 S., R. 2 W.
29	120	Do.
29	121	Burgess ranch, Rancho Laguna de los Palos Colorados.
30	122	Pigott's ranch, Walnut Creek, Rancho Cañada del Hambre.
30	123	Keller's ranch, Clayton, sec. 12, T. 1 N., R. 1 W.
30	124	Do.
30	125	Do.
31	126	Cardoza's ranch, Morgan Territory, sec. 20, T. 1 N., R. 1 E.
31	127	Lacassie's ranch, Walnut Creek, Rancho Cañada del Hambre.
31	128	Do.
Aug. 1	129	Sturgis ranch, Hookston, Rancho Cañada del Hambre.
1	130	Keller's ranch, Clayton, sec. 12, T. 1 N., R. 1 W.
1	131	Do.
1	132	Do.
1	133	Cardoza ranch, Rancho de los Vaqueros.
1	134	Burgess ranch, Rancho Laguna de los Palos Colorados.
1	135	Pigott's ranch, Rancho Cañada del Hambre.
2	136	Lacassie's ranch, Walnut Creek, Rancho Cañada del Hambre.
2	137	Do.
2	138	Cardoza ranch, Rancho Laguna de las Palos Colorados.
2	139	Sturgis ranch, Walnut Creek, Rancho Cañada del Hambre.
2	140	Brubeck's ranch, Rancho Arroyo de los Nueces y Bolbones.
3	141	Oleson ranch, sec. 6, T. 1 N., R. 3 E.
3	142	Do.
3	143	Haffley ranch, sec. 6, T. 1 N., R. 3 E.
3	144	Do.
4	145	Sec. 10, T. 1 S., R. 3 W.
4	146	Do.
5	147	Mount Diablo tract, sec. 13, T. 1 N., R. 1 W.
5	148	Meredith's ranch, SW. $\frac{1}{4}$, sec. 7, T. 1 N., R. 1 E.
6	149	Silva Ranch, sec. 4, T. 2 S., R. 2 E.
6	150	Do.
6	151	Keller's ranch, sec. 12, T. 1 N., R. 1 W.
7	152	Naphtaly's ranch, sec. 3, T. 1 S., R. 2 W.
7	153	Do.
8	154	Silva Ranch, sec. 6, T. 2 S., R. 2 E.
8	155	Do.
8	156	Do.

PLAGUE-INFECTED GROUND SQUIRRELS FOUND IN CONTRA COSTA COUNTY
BETWEEN JUNE 4 AND AUGUST 13, 1909—Continued.

Date.	Serial number.	Location.
Aug. 8	157	Souza Ranch, sec. 6, T. 2 S., R. 2 E.
9	158	Silva Ranch, sec. 6, T. 2 S., R. 2 E.
9	159	Do.
9	160	Olsen Ranch, sec. 6, T. 1 N., R. 3 E.
10	161	Meredith's ranch, SW. $\frac{1}{4}$, sec. 7, T. 1 N., R. 1 E.
10	162	California Vineyard Co., SE. $\frac{1}{4}$, sec. 14, T. 1 N., R. 1 W.
10	163	Do.
10	164	Buckley Ranch, sec. 9, T. 1 S., R. 3 W.
10	165	Sturgis Ranch, Rancho Canada del Hambre.
10	166	Donovan Ranch, sec. 6, T. 1 N., R. 1 E.
11	167	Mount Diablo tract, sec. 14, T. 1 N., R. 1 W.
11	168	Silva Ranch, sec. 14, T. 1 S., R. 3 W.
13	169	Silva Ranch, sec. 6, T. 2 S., R. 2 E.
13	170	Do.
13	171	Do.
13	172	Nunez Ranch, sec. 6, T. 2 S., R. 2 E.
13	173	Do.
13	174	Do.

NOTE.—The dates given in the foregoing list are those on which the diagnosis was confirmed by bacteriological examination.

UNITED STATES.

[Reports to the Surgeon-General, Public Health and Marine-Hospital Service.]

SAN FRANCISCO, CAL.

Last case of human plague: Sickened, January 30, 1908.

Last case of rodent plague: October 23, 1908.

Week ended August 7, 1909.

Sick inspected.....	2
Plague.....	0
Dead inspected.....	80
Plague.....	0
Premises inspected.....	2, 197
Houses disinfected.....	35
Houses destroyed.....	4
Buildings condemned.....	13
Nuisances abated.....	194
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Rats found dead.....	13
Rats trapped.....	2, 054
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Total rats taken.....	2, 067
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Rats identified:	
Mus norvegicus.....	1, 612
Mus rattus.....	48
Mus musculus.....	385
Mus alexandrinus.....	9
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Total.....	2, 054
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Rats identified as to sex:	
Male.....	802
Female.....	817
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Total.....	1, 619
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Rats examined bacteriologically.....	1, 145
Plague rats.....	0
Poisons placed.....	39, 844